



User Manual **ECOSTEP® 54**

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1 About this manual

This user manual describes the stepper amplifier series ECOSTEP®54. It concerns all persons who install, commission and operate ECOSTEP®54 drives.

Further information:

Operation using ECO Studio: „ECO Studio Operation Manual ECOVARIO®, ECOSTEP®, ECOMPACT®“

Programming: manual „Object Dictionary ECOVARIO®, ECOSTEP®, ECOMPACT®“

Motor data: Data sheets series 17S and 23S (stepper motors).

This manual makes the following demands on qualified personnel:

Transport: Personnel trained in handling electrostatic sensitive devices

Installation: Electrotechnically qualified personnel who know the security directives of electrical engineering and automation

Setup/Commissioning: Qualified personnel with a broad knowledge of the fields of electrical engineering, automation and drives.

2 Safety instructions

2.1 Symbols

Table 2.1: Symbols

Pictogram	Warning	Consequences
	General warning about danger	Disregarding this warning may lead to death or serious injuries.
	Warning about dangerous electrical voltages	Disregarding this warning may lead to death or serious injuries.
	Warning about hot surfaces	Disregarding this warning may lead to burns to the skin.

2.2 General notes



Only properly qualified personnel are permitted to perform activities such as transport, installation, commissioning and maintenance of the ECOSTEP®54.

The manufacturer of the machine must generate a hazard analysis for the machine and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.

In case of modifications or retrofits with components of manufacturers other than Jenaer Antriebstechnik, please contact us to clarify that those components are suitable to be assembled with our devices.

Emergency-off equipment must be workable in all operation modes, especially during setup and maintenance.

2.3 Dangerous voltages



Never open the units during operation. Covers and cabinet doors have to be kept closed during operation.

The protective earth conductor has to be properly applied before applying a voltage.

During operation logic and power conductors are live. Never undo electrical connections while they are live!

After disconnecting the device wait at least 3 minutes before touching contacts. Capacitors can still have dangerous voltages present up to 3 minutes after switching off the supply voltage. To be sure measure the DC link circuit and wait till it has fallen below 40 V.

2.4 Danger by hot surfaces



Hot surfaces may cause burns to the skin. As the housing of the ECOSTEP®54 serves also as heat sink during operation the surface temperature may rise to more than 70 °C.

Note: Motor overtemperature sensing is not provided by the drive.

2.5 Danger by unintentional mechanical movements



Unintentional movements of motors, tools or axes may lead to death or serious injuries. ECOSTEP®54 drives can produce strong mechanical powers and high accelerations. Avoid staying in the danger zone of the machine. Never switch off safety equipment! Malfunctions should be repaired by qualified personnel immediately.

2.6 Prescribed use

The stepper motor amplifiers ECOSTEP®54 are components which are built into electrical equipment or machines and can only be used as integral components of such equipment. All notes about technical data and ambient conditions have to be observed.

The device is suitable for pollution degree 2 environment only.

Using the unit in hazardous locations and in ambients containing oil, gas, vapours, dusts, radiations etc. is prohibited if it is not explicitly allowed.

The manufacturer of the machine must generate a hazard analysis for the machine and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.

If one or more servo amplifiers ECOSTEP®54 are built into machines or plants the intended operation of the servo amplifier is forbidden until it has been established that the machine or plant fulfills the requirements of the EC Machinery Directive 2006/42/EC and the EMC Directive 2004/108/EC. Further EN 60204 and EN ISO 12100 parts 1 and 2 have to be observed.

3 Legal notes

3.1 Terms of delivery

Our terms of delivery are based on the „The General Terms of Delivery for Products and Services of the Electrical Industry“ (German: ALB ZVEI) of the Central Association of the Electrical and Electronics Industry (ZVEI e.V.) in their current version.

3.2 Liability

The circuits and procedures in this manual are proposals. Every user has to check the suitability for every special case. Jenaer Antriebstechnik GmbH is not responsible for suitability. Especially Jenaer Antriebstechnik is not responsible for the following damage causes:

- disregarding the instructions of this manual or other documents concerning ECOSTEP®54
- unauthorized modifications of drive, motor or accessories
- operating or dimensioning faults
- Improper use of the ECOSTEP®54 components

3.3 Standards and directives

Stepper motor amplifiers ECOSTEP®54 are components intended to be built in machines or plants for industrial purposes.

ECOSTEP54 complies to the standards and directives listet in the appendix, chapter 9.4.

3.3.1 UL/CSA compliance

The stepper motor amplifiers ECOSTEP 54 are designed in compliance with UL (Underwriters Laboratories Inc.) or cUL respectively (UL 840 and UL 508C in this case).

For further information see UL file number E244038 at www.ul.com.

The UL(cUL) certification is related exclusively to the mechanical and electrical design of the device. UL(cUL) certified servo amplifiers are in accordance with the respective american and canadian fire regulations.

The installation and safety precautions in this documentaion have to be observed.

3.3.2 CE compliance

Stepper motor amplifiers ECOSTEP®54 are components that are intended to be built into electrical plant and machines for industrial use. The manufacturer of the machine is responsible that the machine or plant fulfills the requirements of the EMC directive.

The stepper motor amplifiers ECOSTEP®54 have been tested by an authorized testing laboratory in a defined configuration with the system components which are described in this documentation.

Any divergence from the configuration and installation described in this manual means that you will be responsible for carrying out new measurements to ensure that the regulatory requirements are fulfilled.

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Declaration of Conformity

We, the company

Jenaer Antriebstechnik GmbH
Buchaer Straße 1
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Germany

declare the conformity of the product

Designation: Stepper Motor Amplifier
Type: ECOSTEP®54 XX-XXX-XXX

with the following directives:

EC Directive 2004/108/EC: (EMC Directive)
Applied harmonized standards: EN 61800-3 (EMI Disturbance)
EN 61800-3 (EMI Immunity)
EC Directive 2006/95/EC: (Low Voltage Directive)
Applied harmonized standards: EN 61800-5-1
EN 60204

Issued by: Jenaer Antriebstechnik GmbH
Dipl.-Ing. (FH) Stephan Preuß
General Manager

Place, date: Jena, 18.05.2011

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This declaration does not guarantee specific features.

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4 Technical Data

4.1 Technical data of the power stage

Table 4.1: Technical data of the power stage

Number of motor outputs		4
Max. phase current	A	2.5
Step resolution	Steps/rev.	12,800
Max. output voltage	V _{DC}	U _{DC-BUS} , cf. table 4.2
Max. output power	W	4 x 100
Short-circuit strength of motor output	current limiting in case of short circuit of motor phases against each other and against U _{DC-BUS}	
Minimum inductance of motor winding	mH	min. 1
Length of motor cable	m	max. 10*
Frequency of output current ripple	dependent on current and inductance	
*) Please consult our application department in case of longer cables.		

4.2 Electrical connection data

Table 4.2: Electrical connection data

Logic supply	V_{DC}	20 ... 30, max. 200 mA
Protection required for logic supply	A	3 T
Power supply (U_{DC-BUS})	V_{DC}	24 ... 45
Protection required for power supply	A	10 slow-acting*
*) if required, use an UL-certified automatic circuit breaker 10 A, 60 V_{DC} slow-acting		

4.3 Operating Conditions

Table 4.3: Operating conditions

Ambient temperature	°C	0 ... + 40
Storage temperature	°C	- 10 ... + 70
Air humidity (non-condensing)	5 ... 95% (RH-2 acc. to IEC 61131-2)	
Pollution severity	2 acc. to IEC 61131-2	
Protection class	IP20	
Mounting position	vertical	
Installation altitude	up to 1000 m above mean sea level w/o restriction	
Power loss: if 4 axes traverse with 2.5 A	W	approx. 30
Cooling by means of convection. Heat sink required in case of restricted convection.		

4.4 General technical data

Table 4.4: General technical data: control signals

No.	Control signal	Unit	
1	24 V supply (current draw without outputs)	V _{DC}	24 ±10 %
		A	0.8
8	Digital control signal inputs (user-programmable, or as limit switch inputs)	V _{DC}	LOW 0 – 4, HIGH 13 – 30
		mA	3.4 / 2.4 (at 24 V _{DC})
		kΩ	7
1	Control signal DC link relay (REL+, REL-)	V _{DC}	20 ... 24
		mA	50
8	Digital control signal outputs (4 user-programmable, 4 reserved for holding brakes)	V _{DC}	24 (20 ... 30)
		A	0.5
			Holding brake: max. 0.8 / 0.4 A (100 ms / continuous)
4	Analog inputs		0 V ... +5 V, 10 bit resolution
		kΩ	at DC: R > 250 at f > 250 Hz: R < 15
1	Analog output		-10 V – +10 V, 8 bit resolution

Table 4.5: General technical data: dimensions and weight

Dimensions and weight	Unit	
Dimensions without heat sink (w x h x d)	mm	240 x 62 x 170 (without mating connector)
Dimensions with heat sink (w x h x d)	mm	240 x 102 x 170 (without mating connector)
Weight (without heat sink)	kg	1.8 kg
Weight (with heat sink)	kg	3.4 kg

4.5 Modes for setpoint setting

ECOSTEP®54 provides the following modes for setpoint setting:

- ➡ Online positioning via field bus (RS232, CANopen)
- ➡ Positioning control via SPS interface (digital inputs/outputs)
- ➡ Joystick operation (analog inputs, resolution 10 bit).

4.6 Suitable types of motors

With ECOSTEP®54 stepper motor amplifier various types of stepper motors can be operated, among others the stepper motor series 17S und 23S of Jenaer Antriebstechnik GmbH. Technical data and regulations in this manual only refer to these motors. Technical data of the motors can be retrieved from the motor data sheets or from our homepage www.jat-gmbh.de.

5 Installation

5.1 Mounting

5.1.1 Important notes

- ➔ Make sure that transport and storage did no damage to the units.
- ➔ The ambient air must not be polluted by dust, greases, aggressive gas etc. Eventually appropriate countermeasures have to be taken (installation of filters, frequent cleaning).
- ➔ Depending on the power losses an appropriate ventilation should be provided.
- ➔ Observe the mounting spaces.
- ➔ Use 60/75°C copper wire only. The accessory cables provided by Jenaer Antriebstechnik fulfill these requirements.
- ➔ At installation locations with permanent vibrations or shocks damping measures should be taken into consideration.
- ➔ The device contains electrostatic sensitive devices which can be damaged by improper usage.

5.1.2 Dimensions

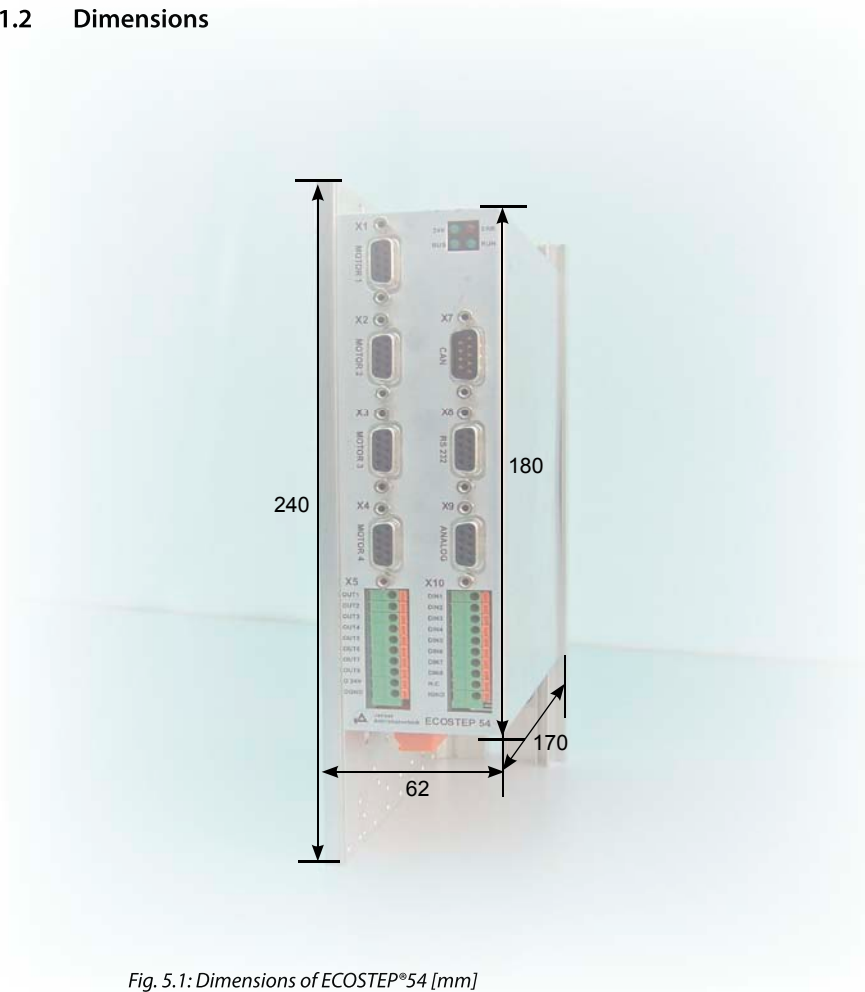


Fig. 5.1: Dimensions of ECOSTEP®54 [mm]

5.1.3 Assembly

When mounting the ECOSTEP®54 into the cabinet cable clamps (contained in connector kit AMK40, cf. chap. 8) assure that the connecting cables are laid EMC conform by connecting the cable shield extensively to chassis earth. Maximum cable diameter is 15 mm.

It is important that the air flow is not disturbed by components above or below the stepper motor amplifiers.

If a heat sink is used (cf. chap. 8.1.1), the mounting space will increase by 40 mm.

The surface of the mounting plate has to be conductive (e.g. zinc plated). Varnished mounting plates must not be used.

To calculate the minimal mounting depth (fig. 5.3, dim A) the form of the connectors (cable outlet direction) and the minimum bending radii of the connecting cables at the sub-D connectors have to be regarded.

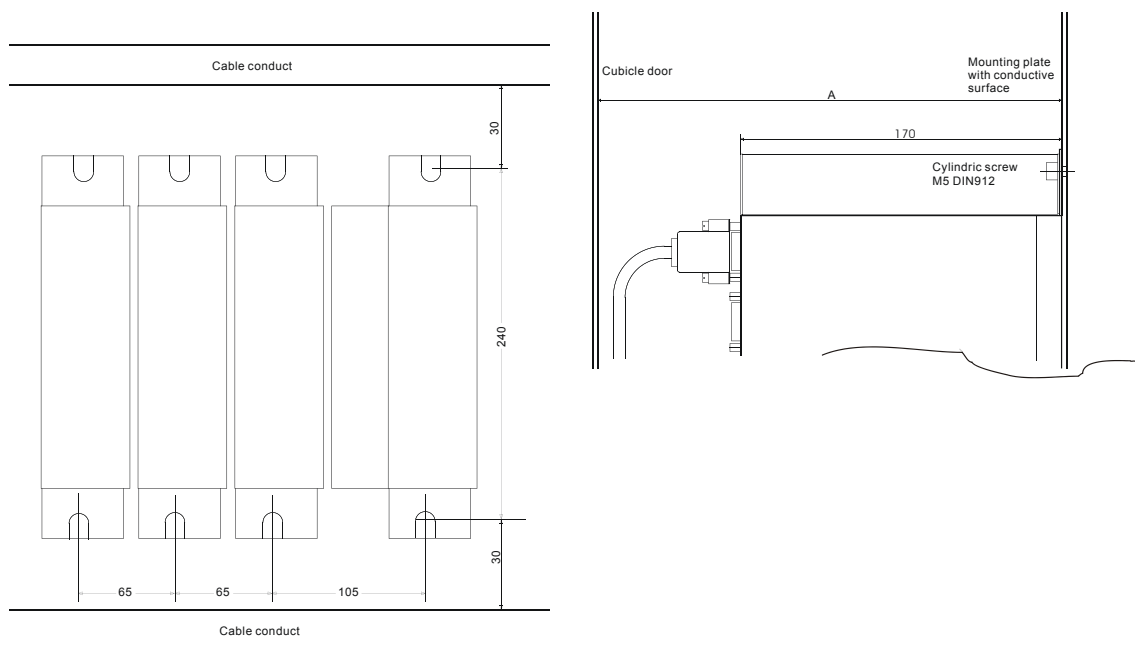


Fig. 5.3: Mounting dimensions cabinet, width and depth [mm]

5.2 Electrical Installation

5.2.1 Important notes

All installation work may only be carried out if the machine or plant is not live and protected against restart.



Never exceed the maximum rated voltage at the connector X11 (power supply) X11! $U_{\max} = 45V_{DC}$

Stepper motor amplifier and motor have to be properly grounded. The protective earth conductor must have at least the same diameter as the supply cables. The stepper motor amplifier should be mounted onto a conductive (not varnished) metal mounting plate.

When the device is used in an UL environment: The device is suitable for use on a circuit of delivering not more than 5 kA_{RMS} symmetrical amperes, 45 V_{DC} maximum when protected by (DIVQ) listed circuit breaker rated 45 V_{DC} and 10 A maximum.

5.2.2 EMC compliant installation

The supply connection of the machine should be equipped with an appropriate RFI suppression filter. Always use shielded cables. Metal parts in the cabinet have to be interconnected extensively and be conductive regarding HF. Used relays, contactors, solenoids etc. have to be protected against overvoltage. Supply cables and motor cables must be laid in a proper distance of control cables.

6 Interfaces

6.1 Arrangement of the interfaces

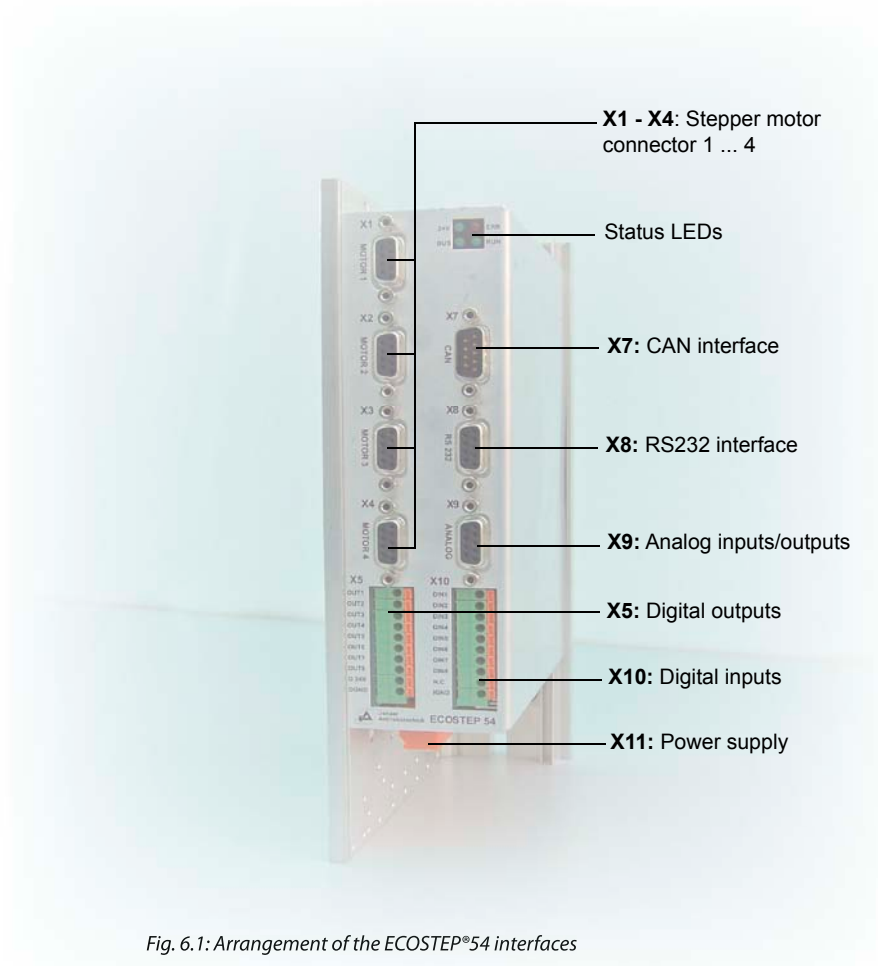


Fig. 6.1: Arrangement of the ECOSTEP®54 interfaces

A mating connector for interface X11 (socket connector 6-pole, WAGO type 231-306) is contained in the connector kit SMK40 (siehe Kap. 9).

Note: The width of the of the D-Sub mating connector handle must not exceed 31.5 mm. (e.g. Harting type 09 67 009 0443).

6.2 Control signals

The control signals are programmable (cf. manual „Object Dictionary ECOVARIO® + ECOSTEP®“).

6.2.1 X5: Digital outputs, 24 V

Table 6.1: Pin assignment connector X5

Signal	Pin	Description
OUT1	1	Digital output 1 (PLC output), $I_{O\max} = 0.5\text{ A}$
OUT2	2	Digital output 2 (PLC output), $I_{O\max} = 0.5\text{ A}$
OUT3	3	Digital output 3 (PLC output), $I_{O\max} = 0.5\text{ A}$
OUT4	4	Digital output 4 (PLC output), $I_{O\max} = 0.5\text{ A}$
OUT5	5	Digital output 5, reserved for holding brake motor 1* $I_{O\max} = 0.5\text{ A}$
OUT6	6	Digital output 6, reserved for holding brake motor 2* $I_{O\max} = 0.5\text{ A}$
OUT7	7	Digital output 7, reserved for holding brake motor 3* $I_{O\max} = 0.5\text{ A}$
OUT8	8	Digital output 8, reserved for holding brake motor 4* $I_{O\max} = 0.5\text{ A}$
O24V	9	24 V supply voltage for digital outputs. Also supplies holding brake outputs on X1 ... X4 .
OGND	10	24 V ground

*) Holding brake output in parallel to X1 ... X4 (cf. chap. 6.3.1). If no holding brake is used, OUT5 ... OUT8 can be used as free programmable digital outputs. Settings via ECO Studio, cf. chap. 7.3, item 9.

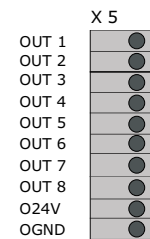


Fig. 6.2: Connector X5:
10-pole cage clamp terminal
(cable diameter max. 0,75²)

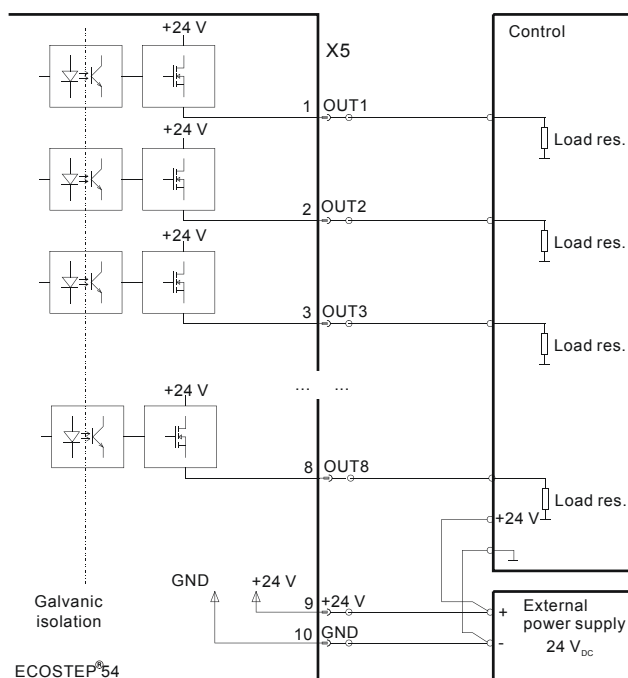


Fig. 6.3: Connector X5: Circuit of the digital outputs

6.2.2 X10: Digital inputs

Tabelle 6.2: Pin assignment connector X10

Signal	Pin	Description
DIN1	1	Digital input 1
DIN2	2	Digital input 2
DIN3	3	Digital input 3
DIN4	4	Digital input 4
DIN5	5	Digital input 5
DIN6	6	Digital input 6
DIN7	7	Digital input 7
DIN8	8	Digital input 8
n.c.	9	n.c.
IGND	10	external 24V ground

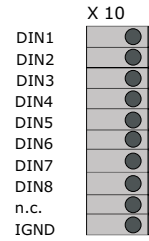


Fig. 6.4: Connector X10:
10-pole cage clamp terminal
(cable diameter max. 0,75²)

Digital inputs can be used e.g. for limit position switches

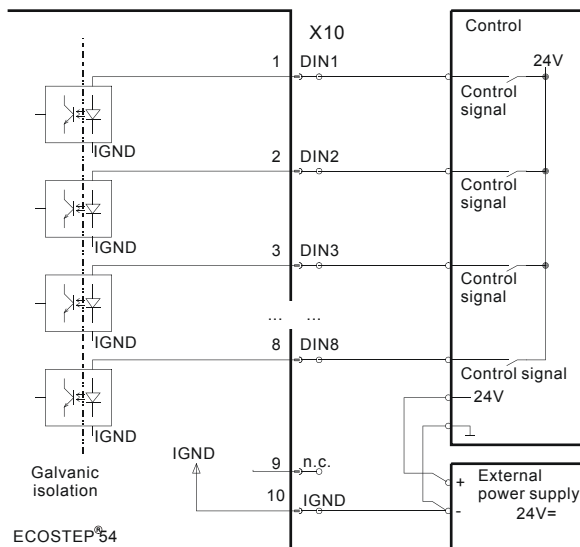


Fig. 6.5: Connector X10: Circuit of the digital inputs

6.2.3 X9: Analog inputs, analog output

Table 6.3: Pin assignment connector X9

Signal	Pin	Description	Value
AN0	1	Analog input 1	0 ... 5 V
AN1	2	Analog input 2	0 ... 5 V
AN2	3	Analog input 3	0 ... 5 V
AN3	4	Analog input 4	0 ... 5 V
GND	5	Internal GND	
+5V	6	Internal 5-V-supply	max. load 20 mA, unprotected!
n.c.	7	n.c.	
DA0	8	Analog output	+/- 10 V
GND	9	Internal GND	

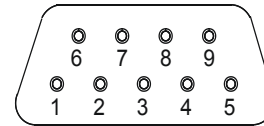


Fig. 6.6: Mating connector X9: 9-pole D-Sub connector, View of the solder or crimp side

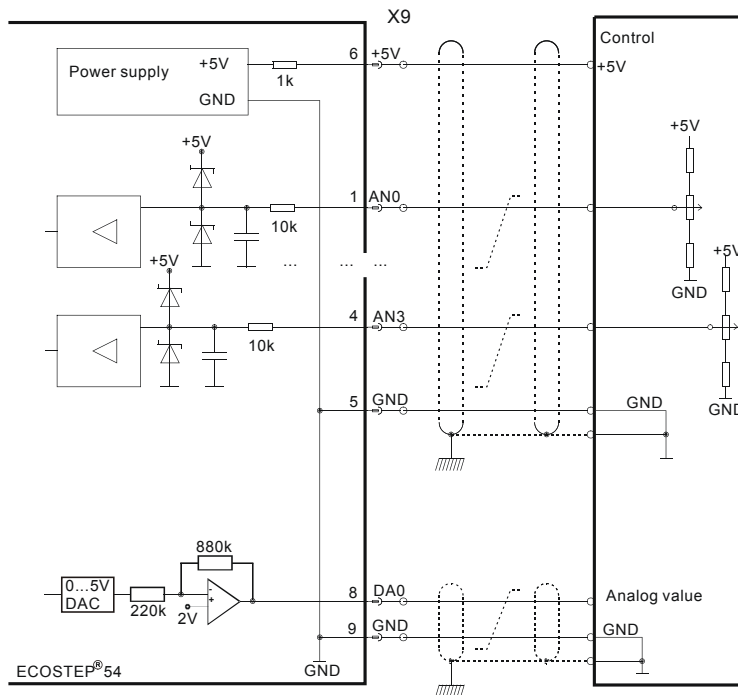


Fig. 6.7: Connector X9: Circuit of the analog inputs and the analog output

6.3 Power connection

6.3.1 X1 to X4: Motor connector

Table 6.4: Pin assignment connectors X1 to X4

Signal	Pin	Description
Phase A	4	Stepper motor connection
Phase /A	3	Stepper motor connection
Phase B	2	Stepper motor connection
Phase /B	1	Stepper motor connection
+24 V	5	Limit position switch supply (max. 20 mA; <u>no direct supply of sensors possible!</u>)
Brake +	6	Holding brake connection (+)
Limit position +	7	PLC input limit position +
Brake -	8	Holding brake connection (-)
Limit position -	9	PLC input limit position -
Shield	shroud	connected to GND via housing



Fig. 6.8: Mating connector X1 to X4: 9-pole D-Sub connector, View of the solder or crimp side

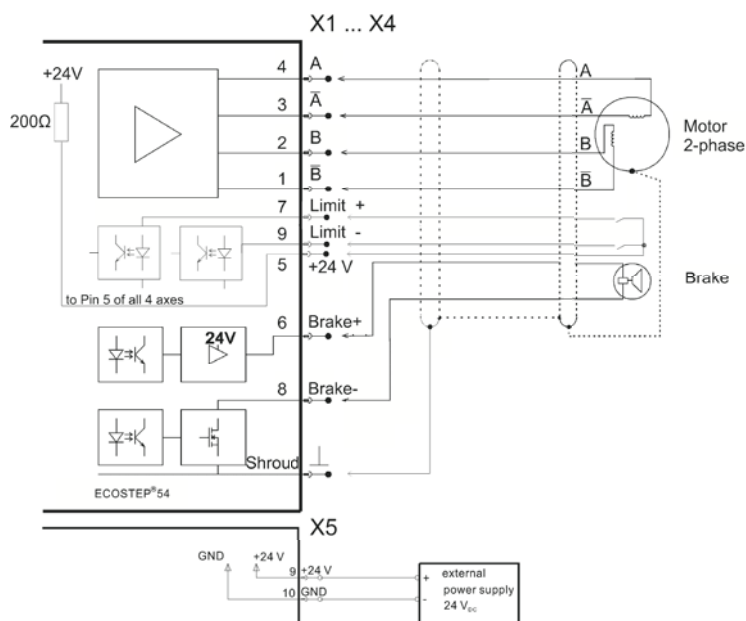


Fig. 6.9: Motor connection

Note: For power supply of the holding brakes a voltage of + 24 V has to be applied to X5, between Pin 9 (+ 24V) and Pin 10 (GND).

6.3.2 X11: Supply voltage

Table 6.5: Pin assignment connector X11

Signal	Pin	Description
24 V logic supply	+24V	Incoming supply voltage +20 ... 30V _{DC} / max. 0.2 A
GND	GND	GND for logic supply
DC link relay +	REL+	Switching on the DC link
DC link relay -	REL -	Switching on the DC link
Power supply +	+ DC BUS	Incoming supply +24V...45V _{DC} / max. 8 A
GND	GND	GND for power supply



Fig. 6.10: Connector X11: 6-pole cage clamp terminal, max. cable diameter 1.5²

Appropriate power supply modules for stepper motor amplifier ECOSTEP®54 from the program of Jenaer Antriebstechnik:

- Power supply 24 V: switch-mode power supply ML70.100, Puls GmbH, 3 ... 5 A
- Power supply 45 V: switch-mode power supply SL10.101, Puls GmbH, 48 V, limit to 45 V.

When the device is used in an UL environment : The device is suitable for use on a circuit of delivering not more than 5 kA_{RMS} symmetrical amperes, 45 V_{DC} maximum when protected by (DIVQ) listed circuit breaker rated 45 V_{DC} and 10 A maximum.

Switching on the DC link

The DC link is switched on by applying a voltage of +24V_{DC} across REL+ and REL-.

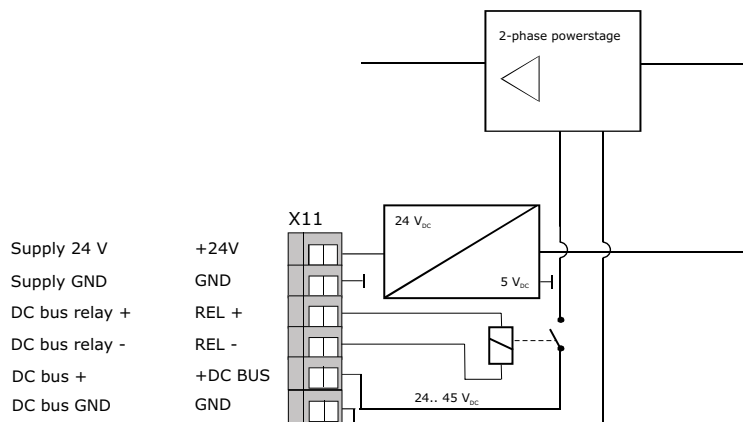


Fig. 6.11: Connector X11, circuit

Line filter

The user has to make sure to conform to the regulations of the EMC Directive (2004/108/EC) by appropriate measures (external line filter, EMC compliant wiring).

Fusing

For external fusing please consider the general technical data (cf. chapter 4.2).

Important Note:

In the power supply of the servo amplifier a NTC resistor serves to limit the inrush current. When supplying a voltage at the lower end of the supply range undervoltage errors may occur in the following cases:

- when switching on multiple axes at the same time
- when accelerating multiple axes at the same time after movement with low load.

In these cases, a higher voltage should be supplied, or the sequence of movement should be optimized, if possible.

6.4 X8: RS232 interface

The stepper motor amplifier ECOSTEP®54 can be completely programmed and parameterized by a PC via the RS232 interface. The connector X8 provides a pinout for direct cabling to a standard PC COM interface. Fat drawn wires are necessary for communication, other wires are for handshaking simulations for special PC programs. The transceiver inside ECOSTEP®54 meets the EIA-232E and CCITT V.28 specifications and provides ESD protection to IEC1000-4-2 (801.2).

Table 6.7: Pin assignment connector X8 R232 interface

Pin	Signal	Description
1	-	n.c.
2	TxD	RS232 TxD
3	RxD	RS232 RxD
4	-	n.c.
5	GND	Digital ground
6	-	n.c.
7	-	n.c.
8	-	n.c.
9	-	n.c.
shroud	Shield	connected to GND via housing

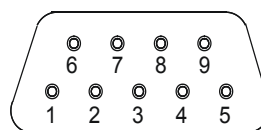


Fig. 6.12: Mating connector X8: 9-pole D-Sub connector, View of the solder or crimp side

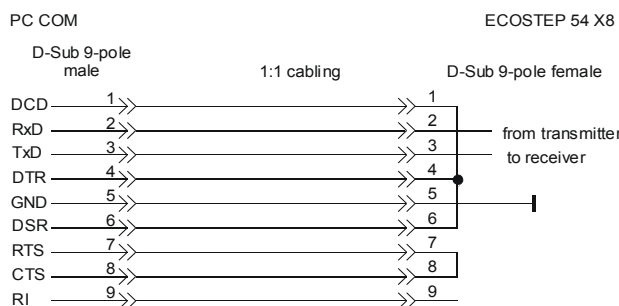


Fig. 6.13: Lines necessary for RS232 communication

The communication protocol provides network operation of up to 15 ECOSTEP®54 devices working as communication slaves in a mono master network. In that case the RS232 cabling must have a loop structure as follows:

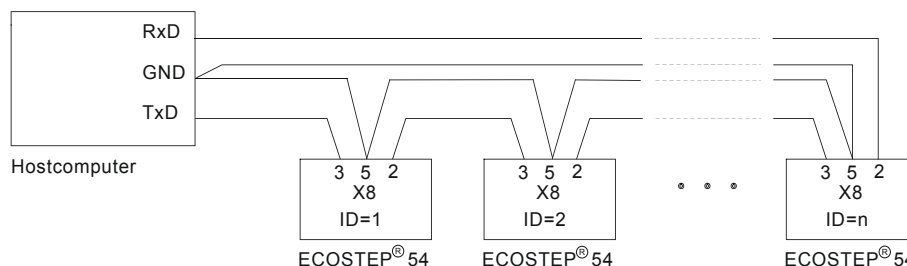


Fig. 6.14: RS232 network as loop structure

6.5 X7: CAN interface

Die CAN interface of the ECOSTEP®54 is based on the communication profile CiA DS 301 and the device profile CiA DSP 402 (drives and motion control). It must be supplied with an external voltage.

Terminating resistors for busses are not built in the ECOSTEP®54. A CAN bus has to be terminated with a 120 Ω resistor at the beginning and at the end. If the ECOSTEP®54 is operated as first or last participant at a CAN bus, it is useful to solder the terminating resistor in the mating connector of X7 between the pins 2 and 7.

The manual „Object Dictionary ECOVARIO® and ECOSTEP®“ contains a detailed description of all available functions. The Baud rate und the device ID can be set via the appropriate CAN objects. By default the ID is set to 1.

The following baud rates are supported: 1 000 kBit/s, 500 kBit/s, 250 kBit/s, 125 kBit/s, 100 kBit/s, 50 kBit/s. If point of sampling and scan rate (86.7 %, 3-times sampling at all Baud rates) do not meet the demands please get in touch with the technical service of Jenaer Antriebstechnik.

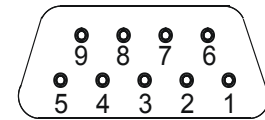


Fig. 6.15: Mating connector X7: 9-pole D-Sub socket; View of the solder or crimp side

Table 6.8: Pin assignment connector X7

Pin	Signal	Description
1	-	n.c.
2	CAN_L	CAN data L
3	CAN_GND	reference potential to CAN data
4	-	n.c.
5	-	n.c.
6	CAN_GND	reference potential to CAN_V+
7	CAN_H	CAN data H
8	-	n.c.
9	CAN_V+	+8 ... + 18 VDC, max. 50 mA

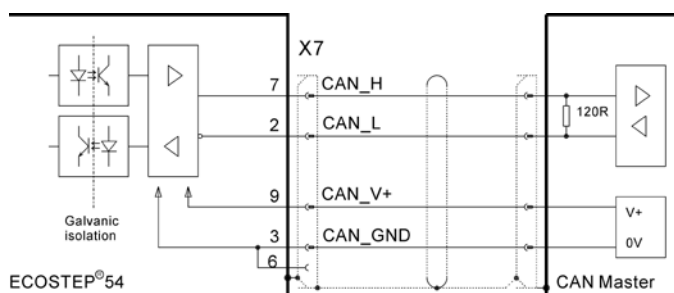


Fig. 6.16: Circuit X7 CAN interface

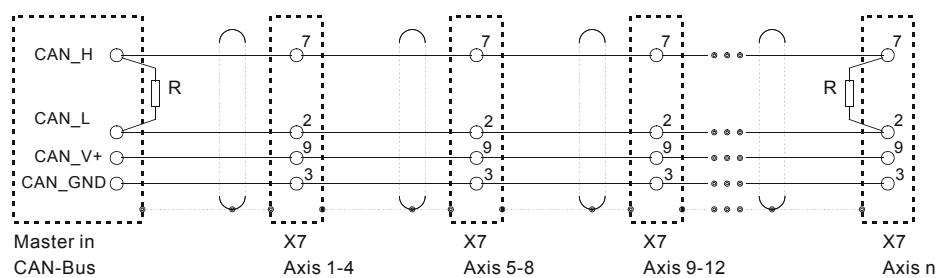


Fig. 6.17: Dimensioning terminating resistors R depending on line impedance; default: $R = 120 \Omega$

7 Commissioning

7.1 Notes before commissioning



Only qualified personnel with a broad knowledge of the fields of electrical engineering, automation and drives are allowed to commission the stepper motor amplifier ECOSTEP®54. If required, Jenaer Antriebstechnik GmbH offers trainings.

The manufacturer of the machine must generate a hazard analysis for the machine and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.

Check the wiring for completeness, short circuits and ground fault.

All live parts must be protected safely against touching.

Never pull the connectors while they are live!

If there are several axes in one machine commission one axis after the other. The axes already commissioned should be switched off.

During operation the temperature of the heat sink and the housing may rise up to over 70 °C. Before touching these parts after switching off the unit wait until the temperature has fallen down to 40 °C.

7.2 Control and display elements

At the front side of the ECOSTEP®54 4 LEDs are located which display status and error messages:

- LED „24V“ (green) on: +24 V logic supply applied and DC link relay switched on (by applying a voltage of +24V_{DC} across pins REL+ und REL- of X11)
- LED „BUS“ (green), communication display: On, if the first character of a telegram has been received. Goes out as soon as the telegram is processed completely.
- LED „RUN“ (green) flashes: software running, stepper motor amplifier ready for operation
- LED „ERR“ (red) on: error message, cf. chap. 7.3, step 4
- LED „ERR“ (red) flashes, all other LEDs off: device in bootloader mode.

7.3 Work schedule commissioning

1. Check installation

The stepper motor amplifier is disconnected from the supply. Check the wiring for completeness, short circuits and ground faults. For commissioning an RS232 connection via a 1:1 cable from socket X8 to COM1 or COM2 of a PC is required. On PC side also a USB interface can be used. In this case the ECO2USB cable has to be applied, which is available as an accessory (cf. chap. 8).

2. Switch off DC link relay

At the socket X11 no voltage must be applied between the pins REL+ and REL-.

3. Switch on 24 V supply

Apply the 24 V logic supply at the connector X11 between the pins GND and +24 V; after an initializing phase of about 3 s the LEDs show the operation mode of the stepper motor amplifier. If this is not the case, check again the logic supply and reset the stepper motor amplifier by switching off and on again the logic supply.

4. Rectify eventual errors

If the LEDs show an error, i.e. the red „ERR“ LED is on, the error has to be rectified before commissioning. Possible error causes:

- ➡ Power supply voltage too low (< 15 V)
- ➡ Heat sink temperature too high (> 80 °C)
- ➡ internal controller error

For further information on the proceeding in case of an error refer to chap. 7.3.1.

5. Start setup software

Install the commissioning and operation software ECO Studio provided on the adjoined CD-ROM to a PC (for the system requirements please refer to the ECO Studio manual). Connect a PC to the RS232 interface of the ECOSTEP®54 and start ECO Studio. For the operation of ECO Studio please observe the online documentation or the ECO Studio Operation Manual, respectively. Context sensitive help is also provided via the F1 key.

6. Communication PC - ECOSTEP54, device address

After ECO Studio has been started, the **Communication: Connect/Disconnect** window is shown. In the **Interface** selection list box select the RS232 interface. In the **Parameters** group box, specify the serial interface of the PC used for the connection (default: COM1) and the baud rate (default: 9600 Baud). Click the **connect** button in order to establish the connection.

Communication: Connect/Disconnect

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Interface

- RS232
- RS485
- CAN via ESD USB Dongle
- CAN via PEAK USB Dongle
- CAN via PEAK Parallel Port Dongle
- CAN via PEAK PCI
- CAN via PEAK PCI2
- USB direct
- ETHERNET
- ETHERCAT
- OFFLINE, Generate Data Set

Parameters

Port: COM1

Baud Rate (Baud): 9600

Description

This interface provides an RS232 connection.

ID

ID	Device	Name	Serial Number	Firmware Version
1	ECOSTEP54		XXXXXXXXXXXXXXXX	SMS10 0000.0009-0002 11.05.2005

ID: 1

search

Options

☒ Error Guard

☐ Connection Guard

Connection

connect

Fig. 7.1: Communication: Connect/Disconnect window

- **ID:** The device address (ID) of an ECOSTEP54 is adjusted to 1 by default and results from the sum of object „node-ID“ (Ox100B,00) and object „node-offset“ (Ox2F80,00). The ID can only be changed via the object „node-offset“ (default=0), as the object „node-ID“ is predefined to 1 and cannot be changed. IDs in the range 1 ... 127 can be assigned, whereas each ID must only be assigned once in one network. If you wish to modify the address, first set the „node_offset“ accordingly. After that the new value has to be stored permanently. The new address is then assigned after the +24 V logic supply is switched on again. Each device communicates also via the „Joker-ID“=127 (7Fh), independent of the ID adjusted at the given instant of time, so that even in the event of a false or unknown configuration a single device can be accessed.

6. Set parameters



The parameters have to be adjusted to each individual application. Incorrect parameter settings can cause damage or destruction of machine parts.

The correct setting of the following parameters is especially important. The settings can be done for all 4 motor outputs (Axis 1 to Axis 4) via the navigation area item **Output Mode** -> **Stepper Motor**:

Output Mode

Stepper Motor | Polarity

Torque / Current	Axis 1	Axis 2	Axis 3	Axis 4
Maximum Current	1.768 A _{rms}	1.768 A _{rms}	1.768 A _{rms}	1.768 A _{rms}
Holding Current	1.412 A _{rms}	1.412 A _{rms}	1.412 A _{rms}	1.412 A _{rms}
Additional Travel Current	2.827 A _{rms}	2.827 A _{rms}	2.827 A _{rms}	2.827 A _{rms}

Resolution	Axis 1	Axis 2	Axis 3	Axis 4
Steps per Pole	256 dec	256 dec	256 dec	256 dec

Delay at ...	Axis 1	Axis 2	Axis 3	Axis 4
Switchover from Travel Current to Stop Current	100 ms	100 ms	100 ms	100 ms
Switch off Power Stage after Activation Holding Brake	100 ms	100 ms	100 ms	100 ms
Voltage Reduction Holding Brake after Unblocking Holding Brake	100 ms	100 ms	100 ms	100 ms

Velocity	Axis 1	Axis 2	Axis 3	Axis 4
Switch Velocity	0.0000 mm/s	0.0000 mm/s	0.0000 mm/s	0.0000 mm/s
Start/Stop Velocity	0.0000 mm/s	0.0000 mm/s	0.0000 mm/s	0.0000 mm/s

Fig. 7.2: Parameter settings for motor and holding brake: Window „Output Mode -> Stepper Motor“

- **Maximum Current:** maximum motor current -> please take from motor data sheet.
- **Holding Current:** phase current at standstill -> please take from motor data sheet.
- **Additional Travel Current:** run current effective in addition to the phase current at standstill -> please take from the motor data sheet.
- **Resolution:** step resolution per motor pole -> please take from motor data sheet (Example: step resolution 256 at 50-pole motor results in 12800 steps/resolution).
- **Switch Velocity:** Velocity value at which switching from sine to rectangular commutation takes place. By switching from sine to rectangular commutation an increase of the torque value is achieved, because at rectangular commutation the motor characteristic can be fully utilized. Unit is mm/s. At the value 0 sine commutation is activated.
- **Start/Stop Velocity:** Velocity after the target position has been reached, normally = 0.

Note: The resulting motor current is limited to the **Maximum Current** in any case, even if the sum of **Holding Current** and **Additional Travel Current** exceeds the **Maximum Current**.

7. Check safety equipment



Before switching on the voltage it is vital to check if all safety equipment that protects from touching live parts and from the consequences of indeliberate movements functions properly.

8. Configure limit position switches

If the limit position switches at the motor connection X1 ... X4 shall not be used, the limit positions can be configured under **Inputs/Outputs** -> **Digital Inputs**.

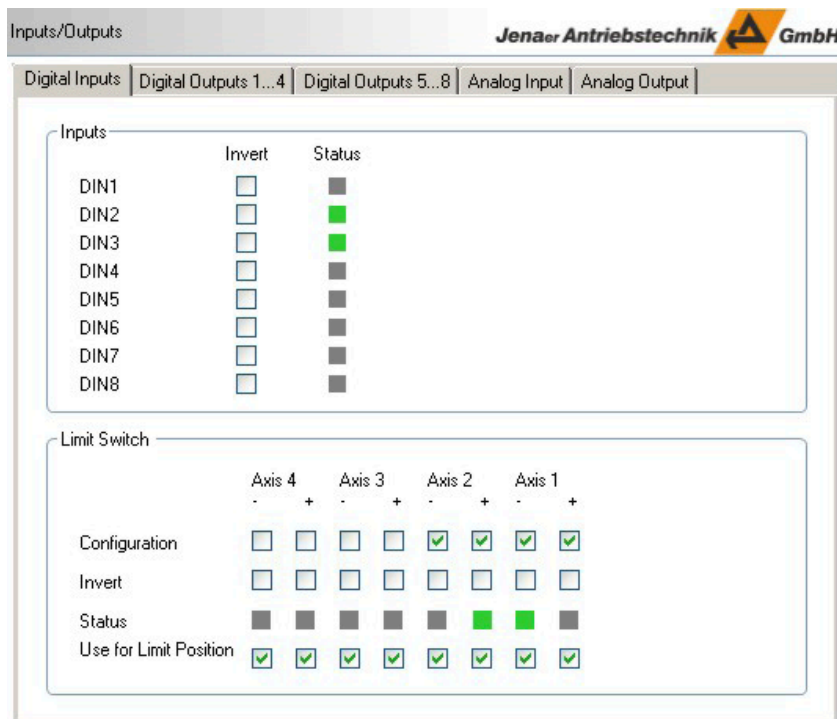


Fig. 7.3: Configuring the limit position switches in the „Digital Inputs“ window

Table 7.1: Parameters and possible settings of digital inputs and limit position switches

Parameter	Description
Window area <i>Inputs</i>	
Invert	If the check box is checked, the applied digital input signal is inverted. I.e., the input is set to „active“ by a LOW-level signal (without inverting the signal a HIGH level sets the input).
Status	State of the digital inputs: grey = inactive, green = active
Windows area <i>Limit Switch</i>	
Configuration	It can be specified whether the digital inputs DIN1 to DIN8 or the inputs at the motor connectors should be used as limit position inputs. If DIN1 to DIN8 should be used, the respective check boxes have to be checked. The inputs at the motor connectors are galvanically not isolated. DIN1 corresponds to positive limit position axis 1 DIN2 corresponds to negative limit position axis 1 DIN3 corresponds to positive limit position axis 2 DIN4 corresponds to negative limit position axis 2 DIN5 corresponds to positive limit position axis 3 DIN6 corresponds to negative limit position axis 3 DIN7 corresponds to positive limit position axis 4 DIN8 corresponds to negative limit position axis 4
Invert	If the connected limit position switch works as a normally open contact: do not set check box If the connected limit position switch works as a normally closed contact: set check box
Status	Green: A limit position event occurred: Limit position switch has been triggered and limit position detection is activated in the stepper motor amplifier.
Use for Limit Position	It can be specified whether for the detection of the respective limit position a limit position switch is used.

9. Configure holding brake

If the holding brake shall be connected alternatively to connector X5 OUT5 ... 8, the mapping of the respective output has to be set to object 0x21240020. AndMask and CmpMask specify the respective output. The settings are done under **Inputs/Outputs** -> **Digital Outputs 5...8**.

The screenshot shows the 'Inputs/Outputs' configuration window with the 'Digital Outputs 5...8' tab selected. The window is divided into four panels, one for each output (5, 6, 7, and 8). Each panel contains the following settings:

- Data Source Mapping:** A dropdown menu showing '21240020' and a text field containing 'break_flags'.
- Offset:** A text field containing '00000000 hex'.
- AND Mask:** A text field containing '00100000 hex' for Output 5, '00200000 hex' for Output 6, '00400000 hex' for Output 7, and '00800000 hex' for Output 8.
- Compare Value:** A text field containing '00100000 hex' for Output 5, '00200000 hex' for Output 6, '00400000 hex' for Output 7, and '00800000 hex' for Output 8.
- Polarity:** A checkbox labeled 'inverting' (unchecked) and a text field containing '00000000'.
- Auxiliary Value:** A text field containing '00000000 hex' and a 'Result' checkbox (unchecked).

Fig. 7.4: Configuring the holding brake in the window „Digital Outputs 5...8“

10. Switch on power supply

11. Switch on DC link circuit

0,5 s after switching on the power supply the DC link circuit relay can be switched on. Therefore, a voltage of + 24V has to be applied across pins REL+ and REL - of connector X11.

12. Set „Switch On“ bit in the control word

The drive is switched on by software. Click the **Switch on Device** button in the left area of the main window.

ECOSTEP54 is controlled via the control word and the status word. Under **Device Status**, the bits of both are displayed for each axis separately and the control word can be modified.

Device Status

Control word					Status word				
Axis	1	2	3	4	Axis	1	2	3	4
	000F	0006	0006	0006		0437	0031	0031	0031
Switch on	☒	☐	☐	☐	Ready to switch on	☒	☒	☒	☒
Enable voltage	☒	☒	☒	☒	Switched on	☒	☐	☐	☐
Quick Stop	☒	☒	☒	☒	Operation enable	☒	☐	☐	☐
Enable operation	☒	☐	☐	☐	Fault	☐	☐	☐	☐
New setpoint	☐	☐	☐	☐	Voltage enabled	☒	☒	☒	☒
Direct setpoint setting	☐	☐	☐	☐	Quick Stop	☐	☐	☐	☐
Absolute - relative setpoint	☐	☐	☐	☐	Switch on disable	☐	☐	☐	☐
Reset fault	☐	☐	☐	☐	Warning	☐	☐	☐	☐
Halt	☐	☐	☐	☐	Manufacturer specific	☐	☐	☐	☐
Reserved 1	☐	☐	☐	☐	Reserved	☐	☐	☐	☐
Reserved 2	☐	☐	☐	☐	Target reached	☒	☐	☐	☐
					Internal limit active	☐	☐	☐	☐
					Setpoint acknowledge	☐	☐	☐	☐
					Reserved	☐	☐	☐	☐
					Commutation found	☐	☐	☐	☐
					Reference found	☐	☐	☐	☐

General Status	
Control word LOW axis 1...4	0606060F hex
Status word LOW axis 1...4	31313137 hex
Status word HIGH axis 1...4	00000004 hex

Fig. 7.5: Control word and status word in the „Device Status“ window

13. Set „Enable Operation“ bit in the control word

The drive is ready now for further commands. The drive can be switched off any time by resetting the „Operation enable“ bit.

14. Carry out homing procedure

The homing procedure can be carried out according to the following methods. The homing method is selected under **Motion -> Homing**:

Table 7.2: Homing methods of ECOSTEP54

Value	Description
17	Homing to the negative limit position
18	Homing to the positive limit position
34	Homing to the actual position

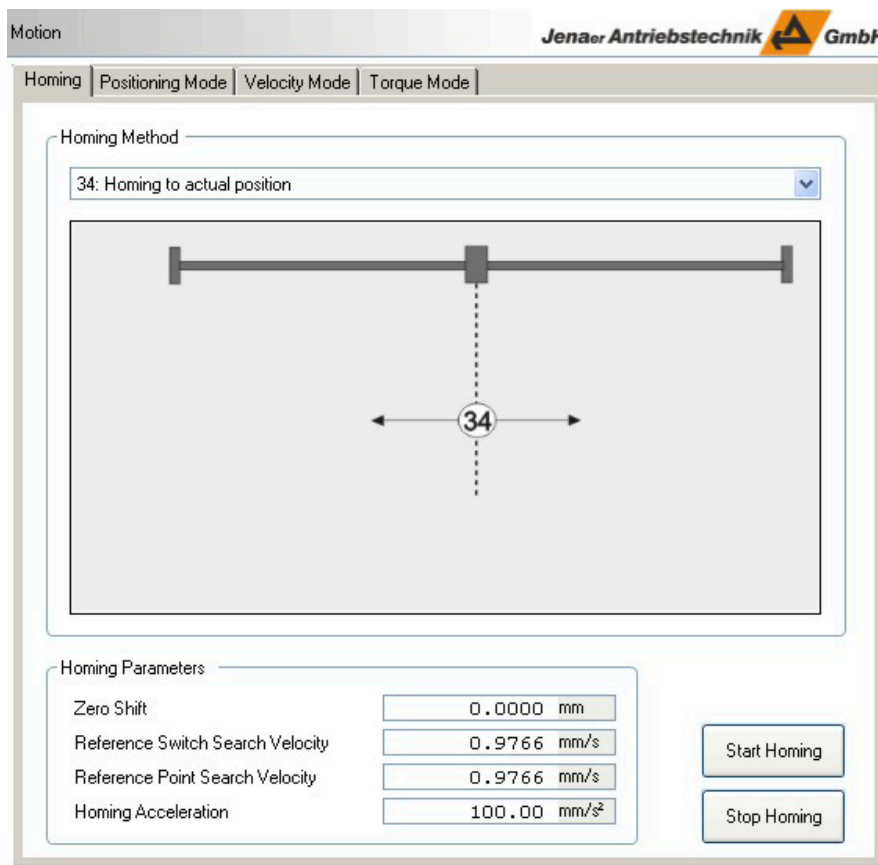


Fig. 7.6: Homing settings

The following homing parameters can be set in the window:

Table 7.3: Homing parameters at ECOSTEP54

Parameter	Description
Zero Shift	After homing has been finished the home position can be shifted with this parameter.
Reference Switch Search Velocity	Velocity of the search travel for the reference switch [mm/s]
Reference Point Search Velocity	Velocity of the search travel for the home position [mm/s]
Homing Acceleration	Acceleration and deceleration during the homing process [mm/s²]

Homing is started with the specified parameters by clicking the **Start Homing** button. As soon as the reference has been found, „Reference found“ is displayed in the message area. In the window area **Device Status** the **Referenced** box is displayed in green colour. Homing can be interrupted by clicking the Stop Homing button.

For PLC programming of the homing procedure you find a flowchart in the Annex (Chap. 9.1).

15. Select operation mode

Besides homing the following operation modes can be selected for the ECOSTEP54 in the navigation area under **Motion**:

- Positioning Mode
- Velocity Mode.

In the Positioning Mode the following parameters can be configured for the 4 controlled axes in the navigation area under **Motion** -> **Positioning Mode** (switching between the axes is done via the menu item **ECOSTEP54**):

The screenshot displays the 'Positioning Mode' configuration window. At the top, there are tabs for 'Homing', 'Positioning Mode', 'Velocity Mode', and 'Torque Mode'. The 'Positioning Mode' tab is active. On the left, there are 'Start' and 'Stop' buttons. The main area is divided into several sections: 'Target Position' with 'absolute' (selected) and 'relative' radio buttons and a text input field; 'Velocity' with 'Profile Velocity' and 'Actual Profile Velocity' text input fields; 'Settings' with 'Acceleration Ramp', 'Deceleration Ramp', 'Jerk Filter', 'Position Window', and 'Position Window Time' text input fields; and 'Limits' with 'Maximum Profile Velocity', 'Positive Software Limit Pos.', 'Negative Software Limit Pos.', and 'Following Error Window' text input fields.

Fig. 7.7: Operation mode Positioning Mode

The parameters are described in the following table.

Table 7.4: Parameters in Positioning Mode for ECOSTEP54

Parameter	Description
Target Position	A target position is specified. The value can be entered either absolute or relative to the actual position with a resolution of 0,1 µm. The entered value becomes only valid when Start has been clicked.
Profile Velocity	Target velocity within the trapezoidal profile
Actual Profile Velocity	Actual target velocity within the trapezoid profile
Acceleration Ramp	Maximum acceleration within the trapezoidal profile in order to reach the target velocity
Deceleration Ramp	Maximum deceleration within the trapezoidal profile

Position Window	Specification of the position window (symmetrical value range around the target position). If the actual position is within the position window the „target reached“ flag is set in the status word.
Positive Software Limit Pos.	Limit position in positive direction, determined by the mechanics of the machine or by setting a positive software limit position.
Negative Software Limit Pos.	Limit position in negative direction, determined by the mechanics of the machine or by setting a negative software limit position.

To start positioning mode with the selected parameters click the **Start** button.

Background information: The positioning mode is controlled by means of 3 bits of the control word:

Table 7.5: Control word in Positioning Mode for ECOSTEP54

Control word (binary)	Description
xxxx0xxxx	The target position can be set without immediate positioning
Transition from xx000xxx to xx001xxx	The drive carries out an absolute positioning according to the defaults in the tab Positioning Mode .
Transition from xx100xxx to xx101xxx	The drive carries out a relative positioning according to the defaults in the tab Positioning Mode .
xx011xxx	New absolute target positions become effective immediately

In the **Velocity Mode** the following parameters can be configured:

Fig. 7.8: Parameters in the Velocity Mode

The parameters are described in the following table.

Table 7.6: Parameters in the Velocity Mode for ECOSTEP54

Parameter	Description
Target Velocity	A target velocity is specified. The travel mode can be specified either with velocity profile by using the acceleration and deceleration ramps (selection profile) or without velocity profile (selection direct) and becomes valid by clicking the Start button.
Actual Target Velocity	Target velocity valid at the moment. Might deviate from the specification in the Target Velocity field if the Start button has not yet been clicked after a new value has been entered.
Acceleration Ramp	Maximum acceleration within the trapezoidal profile in order to reach the target velocity
Deceleration Ramp	Maximum deceleration within the trapezoidal profile
Position Window	Specification of the position window (symmetrical value range around the target position). If the actual position is within the position window the „target reached“ flag is set in the status word.
Maximum Profile Velocity	Velocity limit of the positioning. Depends on the mechanical characteristics of the complete system.

For PLC programming in positioning mode and velocity mode please refer to the flowcharts in the Annex (Chap. 9.1).

Commissioning of the ECOSTEP®54 is now finished. Further configurable parameters (e.g. communication via CANopen) and sequence programming are described in detail in the ECO Studio help system and in the manual „Object Dictionary ECOVARIO®, ECOSTEP®, ECOMPACT®“.

7.3.1 Error case

If an error occurs the red „ERR“ LED on the front side of the ECOSTEP54 goes on and in the status word (**Device Status**) the „Fault“ bit is set.

Fault conditions are evaluated individually for each axis and are displayed in the **Device Errors** tab at the bottom of the main window.

Table 7.7: Error messages in the „Device Errors“ window

Error Message	Measures
Internal controller error	Try to reset the fault condition (see below). If no success, replace device
Heat sink temperature too high (> 80 °C)	Switch off device. Check heat dissipation.
Power supply voltage too low (< 15 V)	Check voltage
Bus error	Check bus connection and device function

Note: Motor overtemperature sensing is not provided by the drive.

Note: Fault conditions always lead to the shutdown of the drive.

After the error cause has been fixed, fault conditions can be reset. After that, the red „ERR“ LED should go out and the „Fault“ bit in the status word should not be set. Otherwise, a fault condition is still present after the reset attempt. Before the drive can be switched on again, the „Switch On“ bit in the control word has to be reset and then set again.

In the navigation area under **Option Codes** the behaviour of the drive in case of shutdown, Quick Stop and fault conditions is specified:

Option Codes
Jenaer Antriebstechnik GmbH

Switch-off behaviour at ...

Quick Stop
0: Drive is switched off and axis coasts down, no braking ramp

Shutdown
0: Drive is switched off and the motor is free to rotate

Disable Operation
0: Drive is switched off and coasts down

Stop (Halt)
0: Drive is switched off and the motor is free to rotate

Fault
0: Drive is switched off and axis coasts down, no braking ramp

Abort CAN Communication
0: Sending out an emergency telegram only

Braking Effect

Switch Off Delay of the Power Stage

Slow Down Ramp
1000.00 mm/s²

Quick Stop Ramp
1000.00 mm/s²

Limit Switch

Limit Switch Used
FF hex

Fig. 7.9: Specifying the behaviour of the drive in case of quick stop, shutdown and fault conditions

Table 7.8: Specifying the behaviour of the drive in case of quick stop, shutdown and fault conditions

Name	Description	Options
Quick Stop	Behaviour in case of „Quick Stop“. Note: Default setting is the switching-off of the drive in case of quick stop. The axis coasts down without controlled braking. Especially with vertical axes (z axes) make sure that the quick stop ramp is configured with a sufficient deceleration (c.f. Braking Effect). If the quick stop ramp is configured too flat, movements could occur with high velocity towards the lower limit position in case of quick stop.	0: Drive is switched off and axis coasts down, no braking ramp (default setting) 1: Slow down on slow down ramp (normal braking case) until standstill, drive is switched off and the motor is free to rotate 2, 3, 4: Slow down on quick stop ramp, drive is switched off and axis rotates freely 5: Slow down on slow down ramp, drive stays in quick stop 6, 7, 8: Slow down on quick stop ramp, drive stays in quick stop
Shutdown	Behaviour of the servo amplifier at the transition OPERATION ENABLE -> READY TO SWITCH ON, i.e. Bit 0 of the control word is set to 0.	0: Drive is switched off and axis coasts down (default setting) 1: Slow down on slow down ramp, drive function is switched off and locked
Disable Operation	Behaviour of the servo amplifier at the transition OPERATION ENABLE -> SWITCHED ON, i.e. Bit 3 of the control word is set to 0.	0: Drive is switched off and axis coasts down (default setting) 1: Slow down on slow down ramp, drive function is switched off and locked
Stop (Halt)	Behaviour of the servo amplifier if bit 8 of the control word is set to 1. Fixed setting is that drive is switched off and the motor is free to rotate.	
Fault	Behaviour of the servo amplifier if a fault occurs in the drive. Guarantees a controlled stop of the drive in case of a fault. Especially with vertical axes (z axes) make sure that the quick stop ramp is configured with a sufficient deceleration (c.f. Braking Effect). If the quick stop ramp is configured too flat, movements could occur with high velocity towards the lower limit position in case of quick stop.	0: Drive is switched off and axis coasts down, no braking ramp (default setting) 1: Slow down on quick stop ramp until standstill, drive is switched off and the motor is free to rotate 2, 3, 4: Slow down on slow down ramp until standstill, drive is switched off and the motor is free to rotate
Abort CAN Connection	Behaviour of the servo amplifier if the CAN connection is aborted. Used with faults in the synchronous mode and in nodeguarding.	0: Sending out an emergency telegram only (default setting) 1: Communication error is set and displayed, drive is switched off without slow down ramp and motor is free to rotate. 2: Drive is switched off immediately, motor is free to rotate, no error display, no emergency telegram 3: Behaviour as specified in the Quick Stop selection list box 4: Function disabled (no action)
Slow Down Ramp	Setting the deceleration for the slow down ramp (normal braking case)	
Quick Stop Ramp	Setting the deceleration for the quick stop ramp	
Limit Switch Used	It can be specified whether for the detection of the respective limit position a limit position switch is used (concerning the assignment cf. Inputs/Outputs -> Digital Inputs)	

8 Accessories

Table 8.1: Survey of ECOSTEP®54 accessories

Order key	Description
Heat sink	
SMH41	Heat sink for ECOSTEP®54 with mounting elements
Connector Kit	
SMK40	Socket connector 6-pole (WAGO type 231-306) as mating connector for X11 Strain relief bushing 20 mm and raised-head screw M3 x 12 (Strain relief and shield connection of the connection cables)
Software tools	
	CD with commissioning and parameterization software HWIN54 including documentation for ECOSTEP®54
Cables and adapters	
ECO2USB	Adapter RS232 to USB, used for parameterization of the ECOSTEP®54 via the USB interface of the PC

8.1 Supplementary parts

8.1.1 Heat sink

The heat sink set consists of:

- 1 heat sink SMH41 for ECOSTEP®54
- 6 screws M5x16
- 6 serrated lock washers 5,3 mm

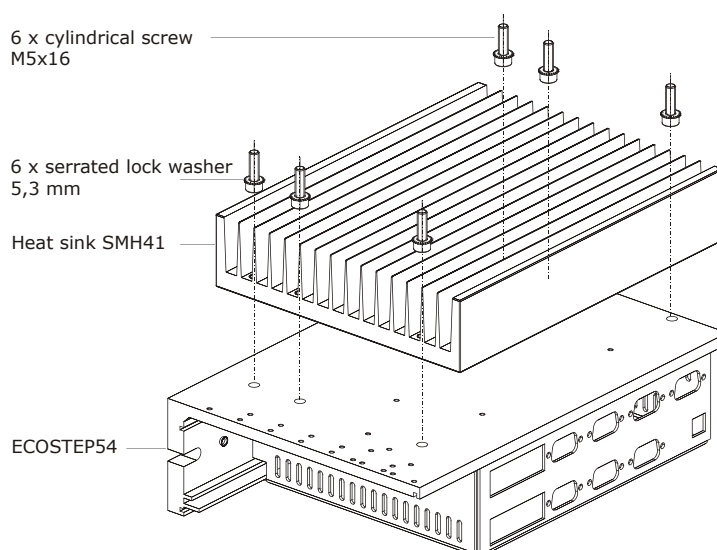


Fig. 8.1: Monting heat sink

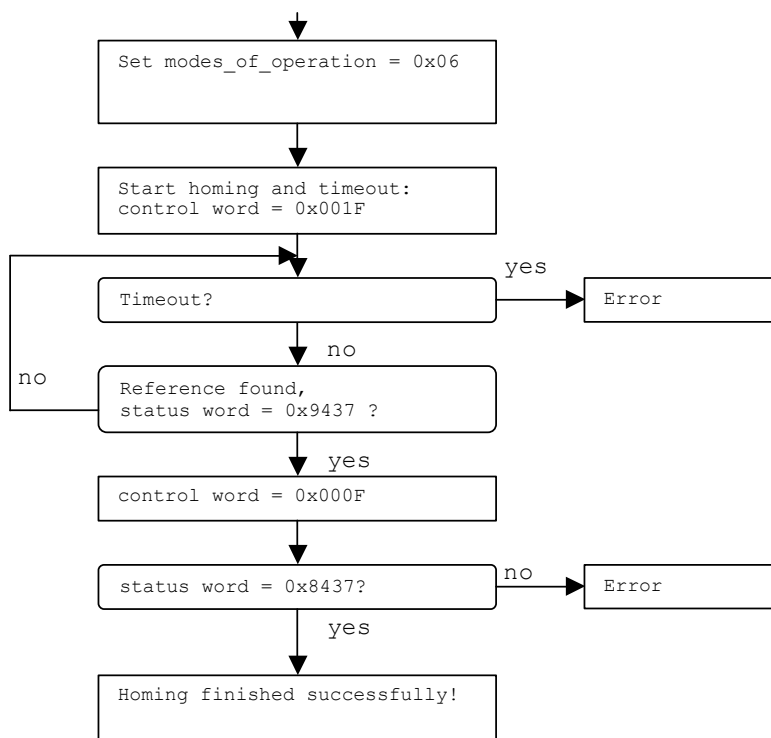
9 Annex

9.1 Flowcharts for PLC programming

9.1.1 Homing

Flowchart homing for EC054 axis, initial situation after power-on:
control word = 0x0006, status word = 0x0031.

For safety reasons every movement of an axis should be monitored by the PLC via timeout.



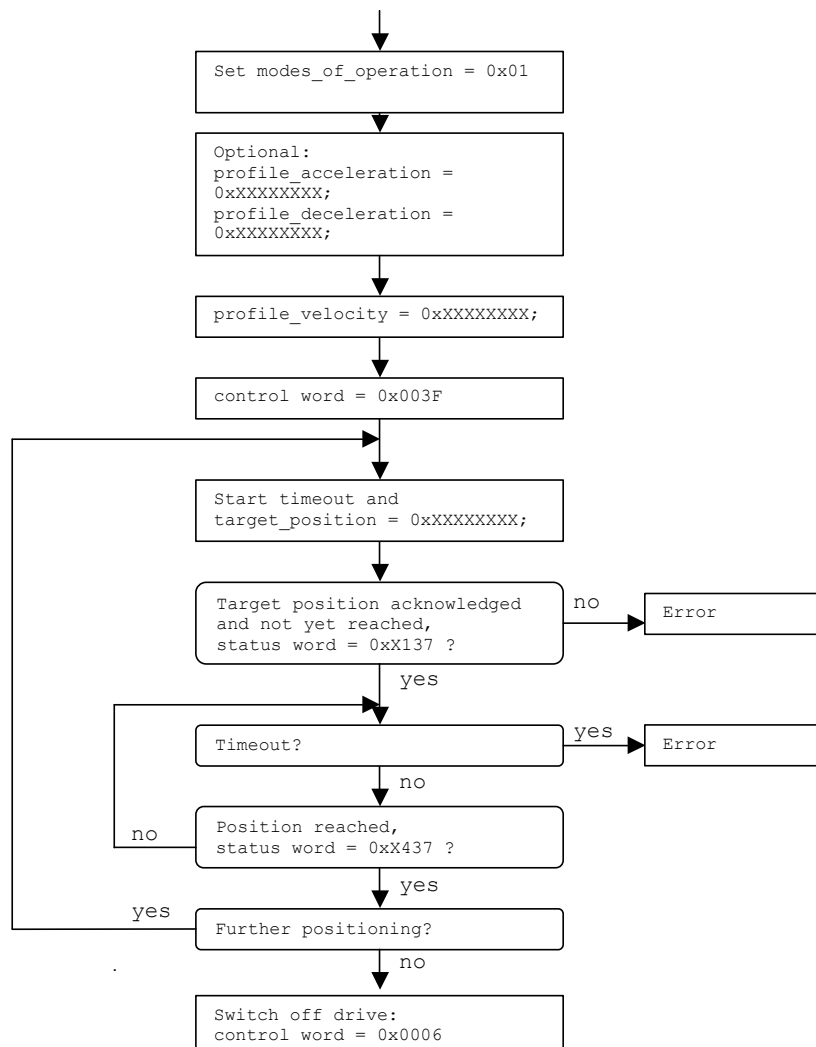
The objects to be written or to be read, resp. for the individual axes are (incl. sub index and length):

	Axis 0	Axis 1	Axis 2	Axis 3
control word	60400010	68400010	70400010	78400010
status word	60410010	68410010	70410010	78410010
modes_of_operation	60600008	68600008	70600008	78600008

9.1.2 Operation mode 1 (Profile Positioning Mode): Direct absolute positioning (effective immediately)

Flowchart positioning mode absolute direct (1) after homing for ECO54 axis.
Status: control word = 0x000F, status word = 0x8437

For safety reasons every movement of an axis should be monitored by the PLC via timeout. The relevant parameters profile_velocity, profile_acceleration, profile_deceleration, quick_stop_deceleration and target_position cannot be manipulated by the PLC if a mapping to other controller parameters (analog input, etc.) exists!



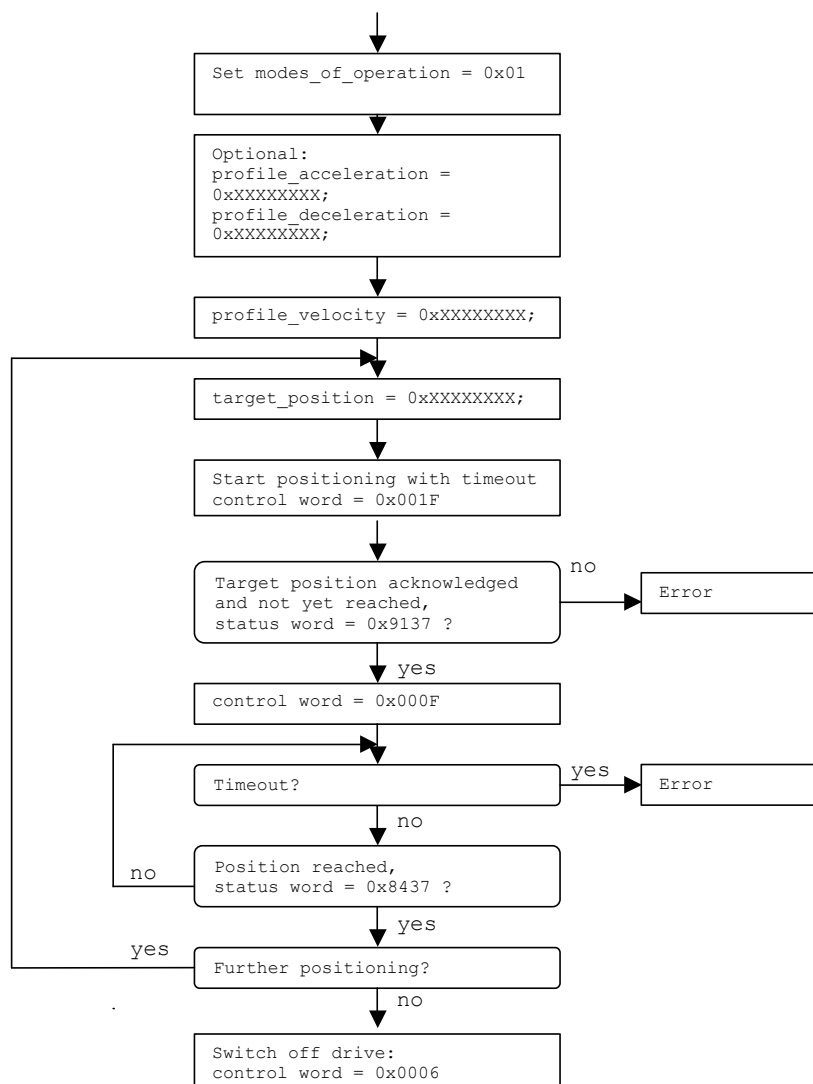
The objects to be written or to be read, resp. for the individual axes are (incl. sub index and length):

	Axis 0	Axis 1	Axis 2	Axis 3
control word	60400010	68400010	70400010	78400010
status word	60410010	68410010	70410010	78410010
profile_velocity	60810020	68810020	70810020	78810020
target_position	607A0020	687A0020	707A0020	787A0020
modes_of_operation	60600008	68600008	70600008	78600008
profile_acceleration	60830020	68830020	70830020	78830020
profile_deceleration	60840020	68840020	70840020	78840020

9.1.3 Operation mode 1 (Profile Positioning Mode): Absolute positioning after setting the control word

Flowchart positioning mode absolute (1) after homing for ECO54 axis 0.
Status: control word = 0x000F, status word = 0x8437

For safety reasons every movement of an axis should be monitored by the PLC via timeout. The relevant parameters profile_velocity, profile_acceleration, profile_deceleration, quick_stop_deceleration and target_position cannot be manipulated by the PLC if a mapping to other controller parameters (analog input, etc.) exists!



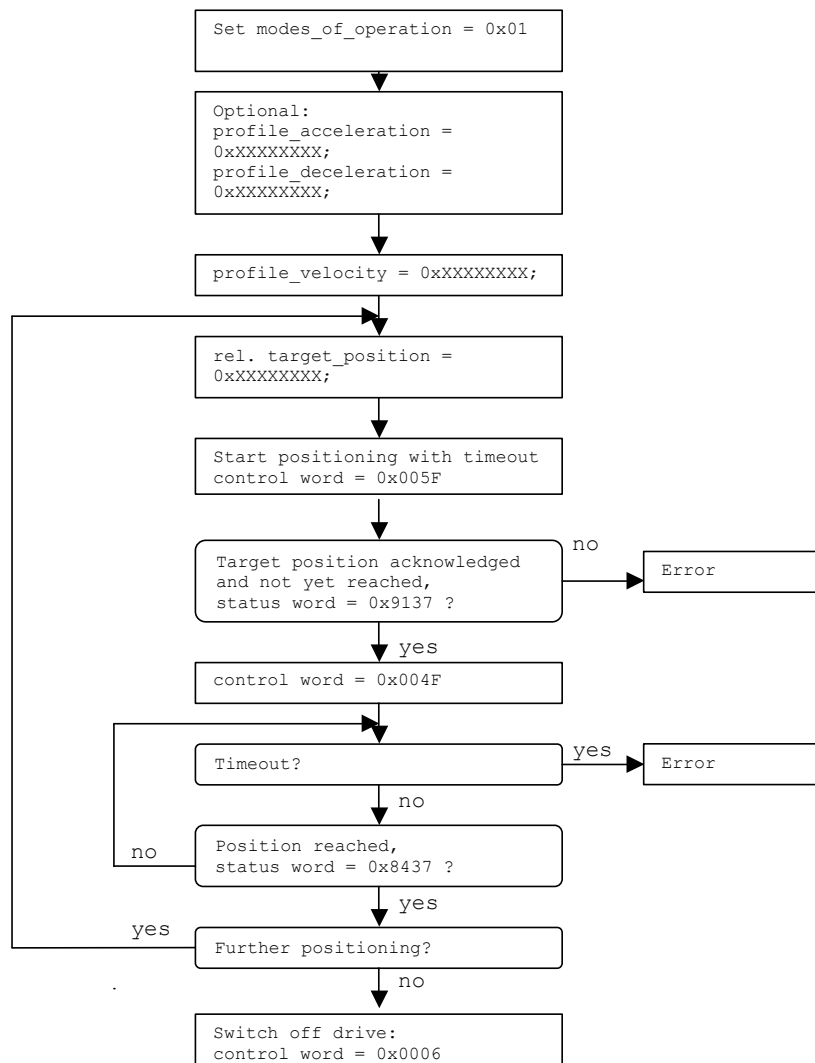
The objects to be written or to be read, resp. for the individual axes are (incl. sub index and length):

	Axis 0	Axis 1	Axis 2	Axis 3
control word	60400010	68400010	70400010	78400010
status word	60410010	68410010	70410010	78410010
profile_velocity	60810020	68810020	70810020	78810020
target_position	607A0020	687A0020	707A0020	787A0020
modes_of_operation	60600008	68600008	70600008	78600008
profile_acceleration	60830020	68830020	70830020	78830020
profile_deceleration	60840020	68840020	70840020	78840020

9.1.4 Operation mode 1 (Profile Positioning Mode): Relative positioning

Flowchart positioning mode relative (1) after homing for EC054 axis 0,
Status: control word = 0x000F, status word = 0x8437

For safety reasons every movement of an axis should be monitored by the PLC via timeout. The relevant parameters profile_velocity, profile_acceleration, profile_deceleration, quick_stop_deceleration and target_position cannot be manipulated by the PLC if a mapping to other controller parameters (analog input, etc.) exists!



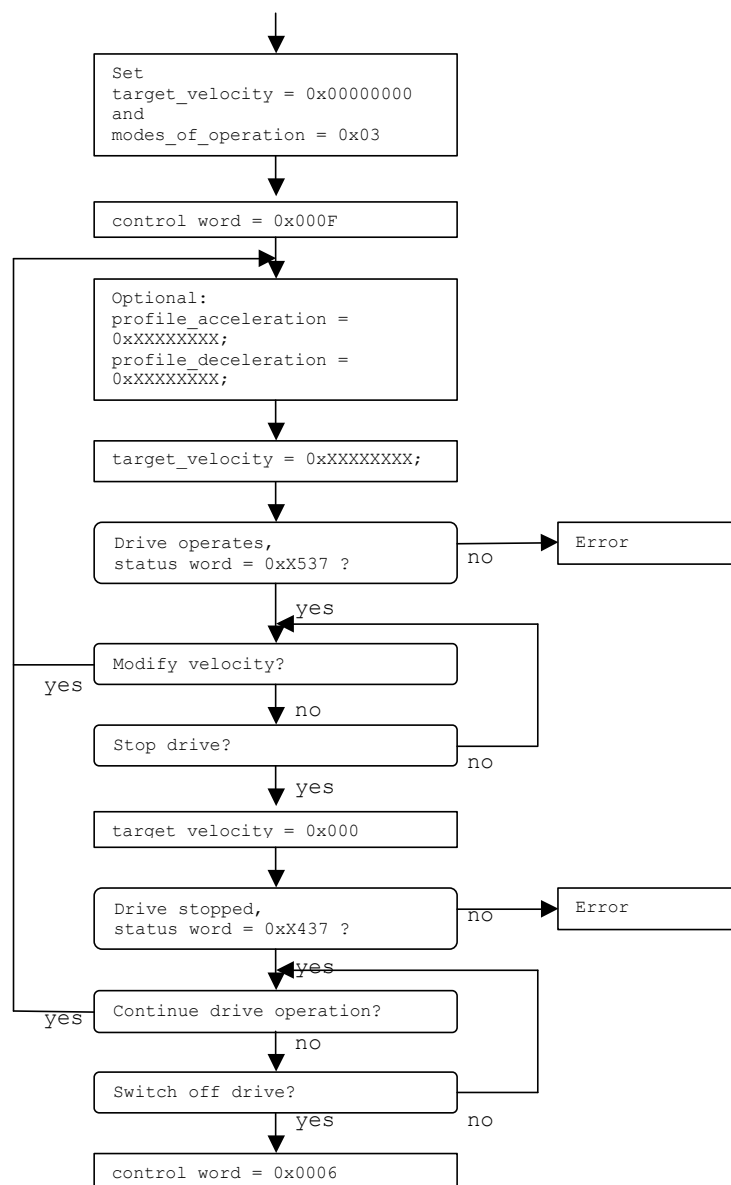
The objects to be written or to be read, resp. for the individual axes are (incl. sub index and length):

	Axis 0	Axis 1	Axis 2	Axis 3
control word	60400010	68400010	70400010	78400010
status word	60410010	68410010	70410010	78410010
profile velocity	60810020	68810020	70810020	78810020
target_position	607A0020	687A0020	707A0020	787A0020
modes_of_operation	60600008	68600008	70600008	78600008
profile_acceleration	60830020	68830020	70830020	78830020
profile_deceleration	60840020	68840020	70840020	78840020

9.1.5 Operation mode 3 (Profile Velocity Mode)

Flowchart velocity mode (3) for ECO54 axis,
Stauts: control word = 0x0006, status word = 0x0031

For safety reasons every movement of an axis should be monitored by the PLC via timeout. The relevant parameter `target_velocity` cannot be manipulated by the PLC if a mapping to other controller parameters (analog input, etc.) exists!



The objects to be written or to be read, resp. for the individual axes are (incl. sub index and length):

	Axis 0	Axis 1	Axis 2	Axis 3
control word	60400010	68400010	70400010	78400010
status word	60410010	68410010	70410010	78410010
target_velocity	60FF0020	68FF0020	70FF0020	78FF0020
modes_of_operation	60600008	68600008	70600008	78600008
profile_acceleration	60830020	68830020	70830020	78830020
profile_deceleration	60840020	68840020	70840020	78840020

9.2 Data Protocol of the RS232 Interface

Generally, the behaviour of the RS232 interface is according to the CAN standard. The CAN protocol is „tunneled“, i.e., the data is transported within the CAN protocol via the serial interface. As device address the CAN Node ID is used.

RS232 communication uses a strictly master slave relation. The host computer only can initiate any data transfer sending a data telegram to the ECOSTEP®54 device listening on the TxD line of the host. This device immediately echoes this byte, i.e. every received byte is transmitted to the next device in the loop ensuring that each slave in loop will receive the host telegram. At the end of the loop the host will receive the data which was sent. The addressed ECOSTEP®54 device computes the received data and sends an answer telegram. Depending on the device position in the communication loop, this telegram is transported via echo from one device to the next and finally to the host.

RS232 communication requires the following interface settings:

- asynchronous communication
- 9600 baud, 8 data bits
- no parity
- 1 stop bit

The transport protocol uses a telegram with a fixed length of 10 bytes.

The host sends:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
ID	8 byte host data								CHKS

Der Host receives the echo (RS232):

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
ID	8 byte host data								CHKS

Der Host receives the answer:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
ID	8 byte slave data								CHKS

ID is the ID No of the addressed slave

CHKS is the telegram checksum. $CHKS = -\sum(\text{byte } 0 \dots \text{byte } 8)$

Note: Each 10 byte telegram has its own checksum.

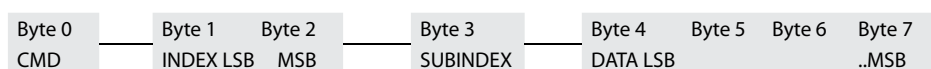
If the host sends a telegram with an unused ID data will pass the loop but no slave answer will return. In that case the host will receive 10 bytes only. The slave finding its own ID in host telegram checks the CHKS value. If the checksum does not match the slave would not generate an answer.

Access to the object dictionary via RS232 will work in the same way as CANopen SDO, excluding segmented data transfer. The 8 byte data of the SDO protocol are extended by 1 byte address (node ID) and 1 byte checksum. The arrangement of the 8 byte data is described in the following. Application of the PDO, SYNC, EMCY and NMT objects is not possible via RS232.

9.2.1 Download Request (Data Transfer from Host to Slave)

Any access to object dictionary is checked for validity by slave. Downloads to not existing objects, readonly objects or data type mismatches are denied and responded with error messages.

The host sends:



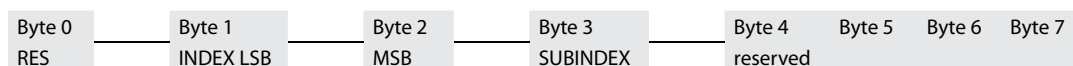
CMD specifies the direction of data transfer and the size of data object
possible values are:
0x23 sending 4 bytes data (bytes 4 ... 7 contain 32 bit value)
0x2B sending 2 bytes data (byte 4 and 5 contain 16 bit value)
0x2F sending 1 byte data (byte 4 contains 8 bit value)

INDEX 16 bit value, index in object dictionary where data should be placed

SUBINDEX 8 bit value, subindex of index in object dictionary where data should be placed

DATA 8, 16, or 32 bit value

The slave answers:



RES displays slave response, possible values are:
0x60 data successfully sent
0x80 error, bytes 4...7 contain error cause

INDEX 16 bit value, index in object dictionary, copy of index in host telegram

SUBINDEX 8 bit value, subindex of index in object dictionary, copy of index in host telegram

reserved not used or error cause, depending on RES

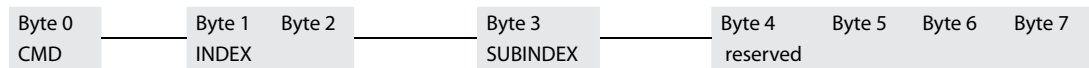
Table 9.1: Example: Writing to the control word (6040,00) value = 0x06 (axis off)

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Transmit:	0x2B	0x40	0x60	0x00	0x06	0x00	0x00	0x00
Receive:	0x60	0x40	0x60	0x00	0x00	0x00	0x00	0x00

9.2.2 Upload Request (Data Transfer from Slave to Host)

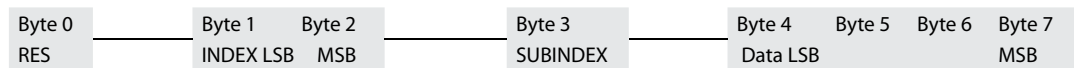
Upload from not existing objects is responded with an error message.

The host sends:



CMD specifies the direction of data transfer
0x40 read access (always)
INDEX 16 bit value, index in object dictionary where requested data reside
SUBINDEX 8 bit value, subindex of index in object dictionary where requested data reside
reserved byte 4 ... 7, not used

The slave answers:



RES displays slave response, possible values are::
0x43 bytes 4 ... 7 contain 32 bit value
0x4B bytes 4 and 5 contain 16 bit value
0x4F byte 4 contains 8 bit value
0x80 error, bytes 4 ... 7 contain error cause
INDEX 16 bit value, index in object dictionary, copy of index in host telegram
SUBINDEX 8 bit value, subindex of index in object dictionary, copy of index in host telegram
DATA data or error cause, depending on RES

Table 9.2: Example: Reading the status word (0x6041,00)

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Transmit:	40	41	60	00	00	00	00	00
Receive:	4B	41	60	00	37	40	00	00
Value of the status word : 0x4037 (axis switched on, no error)								

9.3 Glossary

Baud rate	Unit of measure for the transmission rate of data in serial interfaces. The baud rate indicates the number of possible changes of state of the transmitted signal per second (1 baud = 1 state change/s). The baud rate can be lower than the bit rate (one bit is coded in several signal states). „Baud rate“ in this document refers to signals in which one bit is defined with the two signal states HIGH and LOW. In this case the bit rate equals the baud rate.
Bitrate	Transmission rate of information in bit/second
Bootloader mode	State of the servo amplifier in which a new loadware can be transmitted into the servo amplifier's memory.
DC link voltage	Smoothed DC voltage (here: U_{DC-BUS})
EMC	Electromagnetic compatibility
ESD protection	Protection against electrostatic discharge
Fieldbus interface	Here: CAN
Firmware	Part of the software tha is stored to ROM (read-only memory), the firmware contains the start-up routines.
Ground fault	Here: electrically conductive connection between a power system or motor phase and the PE conductor
Host	Computer in a multi computer system that controls the whole system
ID number	Identification number of a special device in a bus structure
Loadware	Part of the software that can be stored to the flash memory of the servo amplifier
Node	Device connection in a bus structure
RMS	Root mean square
Short circuit	Here: electrically conductive connection between two power systems or motor phases
Watchdog	Supervisory software

9.4 Index of standards and directives

DIN EN 954-1: Safety of machinery - Safety related parts of control systems - Part 1: general principles for design

DIN EN 50170: General purpose field communication system

DIN EN 50178: Electronic equipment for use in power installations

DIN EN 60204: Safety of machinery - electrical equipment of machines - Part 1: General requirements

DIN EN 61800-3: Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods

DIN EN 61800-5-1: Adjustable speed electrical power drive systems - Part 5-1: Safety requirements; Electrical, thermal and energy

DIN EN ISO 12100-1: Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology

DIN EN ISO 12100-2: Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles

IEC 61000-4-2: Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

IEC 61000-4-4: Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test

2006/42/EC: Directive of the European Parliament and the Council on the approximation of the laws of the Member States relating to machinery

2006/95/EC: Council Directive on the harmonization of laws of Member States relating to electrical equipment designed for use within certain voltage limits

2004/108/EC: Council Directive on the approximation of the laws of the Member States relating to Electromagnetic Compatibility